PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

United States Patent and Trademark Office
(Box PCT)
Crystal Plaza 2
Washington, DC 20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 26 October 1998 (26.10.98)	
International application No. PCT/SE98/00347	**Applicant's or agent's file reference** 2986050
International filing date (day/month/year) 26 February 1998 (26.02.98)	**Priority date** (day/month/year) 28 February 1997 (28.02.97)
Applicant THURÉN, Anders	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

28 September 1998 (28.09.98)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was [ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland** Facsimile No.: (41-22) 740.14.35	Authorized officer N. Fischer Telephone No.: (41-22) 338.83.38

09/380270

PATENT COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 2986050	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/SE 98/00347	International filing date (*day/month/year*) 26 February 1998	(Earliest) Priority Date (*day/month/year*) 28 February 1997
Applicant Micronic Laser Systems AB et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. [ ] **Certain claims were found unsearchable** (See Box I).

2. [ ] **Unity of invention is lacking** (See Box II).

3. [ ] The international application contains disclosure of a **nucleotide and/or amino acid sequence listing** and the international search was carried out on the basis of the sequence listing
   - [ ] filed with the international application.
   - [ ] furnished by the applicant separately from the international application,
     - [ ] but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
   - [ ] transcribed by this Authority.

4. With regard to the title,
   - [X] the text is approved as submitted by the applicant.
   - [ ] the text has been established by this Authority to read as follows:

5. With regard to the abstract,
   - [X] the text is approved as submitted by the applicant.
   - [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is:

   Figure No. 1C
   - [ ] as suggested by the applicant.
   - [X] because the applicant failed to suggest a figure.
   - [ ] because this figure better characterizes the invention.
   - [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/00347

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G06K 15/12, G03F 7/20, G06T 11/20, H04N 1/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G06K, G03F, G06T, H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0467076 A2 (MICRONIC LASER SYSTEMS AB), 22 January 1992 (22.01.92) --	1-14
A	US 5533170 A (ROBIN L. TEITZEL ET AL), 2 July 1996 (02.07.96) -- --------	1-14

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 August 1998	14 -08- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jan Silfverling Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

27/07/98

International application No.
PCT/SE 98/00347

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0467076 A2	22/01/92	DE 4022732 A	20/02/92
		DE 59107376 D	00/00/00
		JP 6083023 A	25/03/94
US 5533170 A	02/07/96	AU 5410294 A	24/05/94
		CA 2148121 A	11/05/94
		EP 0664033 A	26/07/95
		JP 8505003 T	28/05/96
		WO 9410633 A	11/05/94

PATENT COOPERATION TREATY

09/380270

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 2986050	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/SE98/00347	International filing date *(day/month/year)* 26.02.1998	Priority date *(day/month/year)* 28.02.1997
International Patent Classification (IPC) or national classification and IPC6 G 06 K 15/12, G 03 F 7/20, G 06 T 11/20, H 04 N 1/04		
Applicant Micronic Laser Systems AB et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of ______ sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand 28.09.1998	Date of completion of this report 20.06.1999
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Telex 17978 PATOREG-S Facsimile No. 08-667 72 88	Authorized officer Jan Silfverling/MN Telephone No. 08-782 25 00

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SE98/00347

I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

☒ the international application as originally filed.

☐ the description, pages ______, as originally filed,
pages ______, filed with the demand,
pages ______, filed with the letter of ______,
pages ______, filed with the letter of ______.

☐ the claims, Nos. ______, as originally filed,
Nos. ______, as amended under Article 19,
Nos. ______, filed with the demand,
Nos. ______, filed with the letter of ______,
Nos. ______, filed with the letter of ______.

☐ the drawings, ~~sheets~~/fig ______, as originally filed,
~~sheets~~/fig ______, filed with the demand
~~sheets~~/fig ______, filed with the letter of ______,
~~sheets~~/fig ______, filed with the letter of ______.

2. The amendments have resulted in the cancellation of:

☐ the description, pages ______
☐ the claims, Nos. ______
☐ the drawings, ~~sheets~~/fig ______

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

V. Resoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-14	YES
	Claims		NO
Inventive step (IS)	Claims	1-14	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-14	YES
	Claims		NO

2. Citations and explanations

The invention relates to microlithography, in particular to the writing of photomasks for computer displays, microelectronic devices, and precision photoetching. The claims state a method and an apparatus for fast and accurate writing of very complex patterns on a light sensitive surface. The surface is scanned by at least two modulated focused laser beams in interlaced parallel scan lines. Each beam is provided with a beam processor with data conversion logic and means for modulating the laser beam. Input data is provided, which contains the geometries to be written. First the input data is fractured into writing fields and then the fractured data is cut into scan lines. For each scan line there are generated a scan list containing geometries to be written in the scan line. At least two processors are working in parallel, but on different writing fields. The lists of segments in the scan lists are converted to analog power modulation sequences for the laser beams.

Documents cited in the International Search Report:

D1: EP 0467076
D2: US 5533170

D1 and D2 show similar systems, but they do not show systems according to claims 1 and 14, and are only cited to show the state of the art.

Therefore, the invention according to claims 1-14 is considered to be novel and to have inventive step and industrial applicability.

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International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G06K 15/12 | A2

(11) International Publication Number: WO 98/38597

(43) International Publication Date: 3 September 1998 (03.09.98)

(21) International Application Number: PCT/SE98/00347

(22) International Filing Date: 26 February 1998 (26.02.98)

(30) Priority Data:
9700742-1 28 February 1997 (28.02.97) SE

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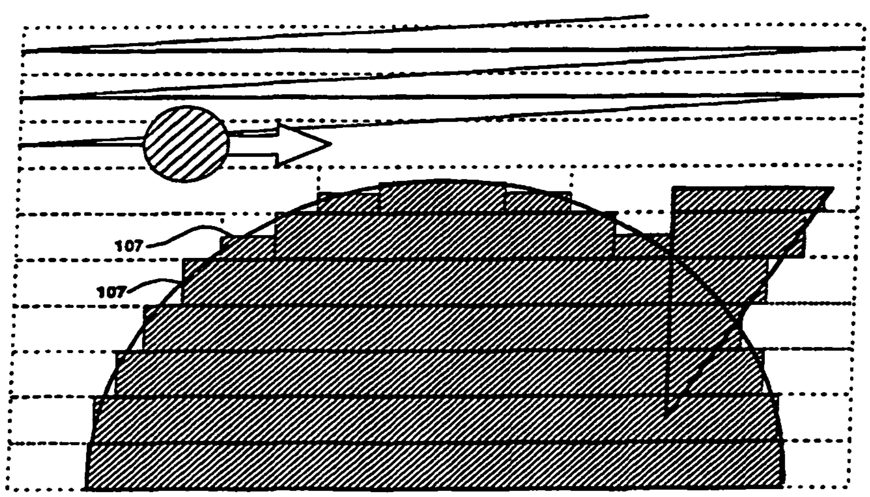
(72) Inventor; and
(75) Inventor/Applicant (*for US only*): THURÉN, Anders [SE/SE]; Torgnyvägen 21, S-183 72 Täby (SE).

(74) Agent: AWAPATENT AB; P.O. Box 11394, S-404 28 Göteborg (SE).

(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: DATA-CONVERSION METHOD FOR A MULTIBEAM LASER WRITER FOR VERY COMPLEX MICROLITHOGRAPHIC PATTERNS



(57) Abstract

The invention relates to microlithography, in particular to the writing of photomasks for computer displays, microelectronic devices, and precision photoetching. It is also applicable to wafers, optical devices and a variety of electronic interconnection structures such as multichip modules. Other applications are possible, such as printing and graphics, as well as laser projection displays. In the present invention the data conversion is divided in two steps: first cutting the geometries in scan lines and simplifying them, and then finishing the conversion of the scan lines at the point of demand, i.e. in a beam processor in the driving electronics for each beam. The idea is to make as much as possible of the conversion at the latest possible point, i.e. at the beams. What is needed at an earlier stage is to separate the data for different beams and distribute them, and to simplify the data enough to make sure that the beam processors can always handle the data flow.

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DATACONVERSION METHOD FOR A MULTIBEAM LASER WRITER FOR VERY COMPLEX MICROLITHOGRAPHIC PATTERNS

Field of the invention

The invention relates to microlithography, in particular to the writing of photomasks for computer displays, microelectronic devices, and precision photoetching. It is also applicable to wafers, optical devices and a variety of electronic interconnection structures such as multichip modules. Other applications are possible, such as printing and graphics, as well as laser projection displays.

Background of the invention

The application discloses a method for data conversion at extremely high through-put in a multi-beam laser plotter. The need for such high capacity comes from two sources: the ever-increasing number of features on photomasks, and increasingly sophisticated designs. For both computer displays, consumer TV screens and microelectronic products there is a rapid development towards at the same time larger sizes and smaller elemental cells. The development is most dramatic with semiconductor memories where a photomask could contain a billion elemental geometries or more. Furthermore, the elemental geometries need not be rectangular, but could be of any shape.

The input data file may be in a compacted hierachical format, but during processing the data volume increases immensely (up to 1000-10 000 Gb per mask) and it is impossible to process the data beforehand and store the data until the time of writing. The datapath must therefore have enough processing capacity to convert the data in real time.

Another issue is the necessity of a small address grid. The writing system for semiconductor masks must be capable of writing features specified in units of 10 nm (nanometers) or less. It has been disclosed in European

(nanometers) or less. It has been disclosed in European Patent EP 0 467 076 by the same inventor that a combination of time delays and analog power modulation can be used to achieve an arbitrarily small address grid. The same patent also discloses the use of several beams and parallel data paths to increase the through-put of the writing system.

For a writer with two laser beams two parallel data paths may be feasible, but current multibeam writers may use up to 32 beams and simple multiplication of a single-beam datapath would be practically impossible.

There is also a strong desire to have unequal numbers of processors and beams, in particular a much larger number of processors than beams. A second need is to make the system easily scaleable, so that writers for different applications with different requirements on capacity can be configured from standard modules and running identical software.

In United States Patent US 5 533 170 a high-throughput multibeam data path based on parallel rasterizers is disclosed. Each rasterizer, "geometry engine", converts a frame of the pattern to a pixel map where each pixel has a greyscale value from 0 to 16. The bitmaps are distributed to beam boards via a bus system and loaded into a buffer RAM area in each bus board.

The method in US 5 533 170 requires very high processing power. In particular every pixel has to be filled with its proper value and transmitted to the beam boards for writing. This is done by signal processors and custom ASICs. The writing system has a burst pixel rate of 1600 million pixels per second, and extremely high demands are placed on the internal data paths. Therefore a system with parallel buses is used and the result is a complex, costly and inflexible system.

The present invention devices a method for data conversion that can be used on configurations from one

beam/one processor to tens of beams/hundreds of processors.

Brief summary of the invention

In the present invention the data conversion is divided in two steps: first cutting the geometries in scan lines and simplifying them, and then finishing the conversion of the scan lines at the point of demand, i.e. in a beam processor in the driving electronics for each beam. The idea is to make as much as possible of the conversion at the latest possible point, i.e. at the beams. What is needed at an earlier stage is to separate the data for different beams and distribute them, and to simplify the data enough to make sure that the beam processors can always handle the data flow.

There are benefits with the invention in three areas:

- there is nowhere in the system a pixel map that has to be filled, therefore a lot of processing power is saved
- keeping the information to the beam processors in geometrical form instead of as a pixel map gives a smaller data volume, making the implementation simpler and more flexible. Practical tests indicate savings of 4 - 20 times depending on the pattern.
- the manipulation of the geometrical data without filling operations is well suited for algorithmic programs running on a general-purpose processor, while the final processing in the beam boards is better served with custom-logic. Using general purpose processors gives great flexibility. It is possible to increase the performance simply by moving to faster processors as they become available, and it is easy to modify or refine the algorithms to follow the needs of the applications. Custom algorithms for specific applications or new input formats are easily implemented.

Brief description of the drawings

Figure 1a shows how a round shape 101 combined with a triangular shape 102 are represented by a pixel map 103 with analog intensities (shown as varying shading). The beam 104 is scanning parallel lines 105. The size of the writing light spot is larger than a pixel, therefore the result on the plate will be smoothened to a round figure.

Figure 1b shows the same shapes as in Figure 1a, but where the geometrical shape are cut into segments 106 belonging to different scanlines.

Figure 1c shows the same shapes as in Figure 1b, but where the segments are replaced by a simplified new segment 107, with only length and width. As in Figure 1a the size of the spot will make the written figure smooth.

Figure 1d shows the segments in Figure 1c converted to analog values by the beam processor.

Figure 2 shows three beams 201, 202, 203 forming interlaced scan lines with the spacing 206. The figure shows that the beams scan three lines and then retrace while the stage is advanced a distance 207 equal to three times the scan spacing. There are several possible spacings 205 between the beams, here two times the scan spacing 205 is shown.

Figure 3 shows a preferred embodiment of the invention with two beams and two segmentizers.

Figure 4 shows a preferred embodiment with tree beams and four segmentizers.

Figure 5 shows how data is buffered to allow all components to run continuously at full capacity in another preferred embodiment with four segementisers and three beams.

Function of the invention

Figure 3 shows an embodiment with two processors and two beams writing on a workpiece 301 using a demagnification and focusing lens 305. The scanning and advancement between the scans, not shown in this figure, can be

done by the stage or the beams or by a combination of the two. The pattern, shown as a figure 306 in a square window 307, is described in the input data read from tape 308 or from a network 309. The input can be stored on local mass storage 310, e.g. on a local hard disk, by the host computer 311. The host computer sends the input data to the segmentizers 312, 313 after having performed any necessary format conversions, scalings, expansion of hierachical structures, etc. It may use mass storage 310 for intermediate storage at any time. Furthermore it cuts the data into fields that are suitable to the length of the scan lines and to the size of the data buffers in the data path. Depending on the complexity of the data a field can be chosen to be a full writing swath or part of a swath.

The host computer sends the data for each field to one of the segmentizers 312, 313, typically in the order they need to be written and to the first available segmentizer. The host computer maintains a table of where the data for each field is and its status.

The segmentizers cut the data to each scan line and forms a list of geometrical elements for each scan line and a list of scan lines 316, 317. Although the function of the invention does not depend on it, the segmentizer may simplify the geometries in each scan line, remove any overlapping geometries and form segments that are rectangles with length and width and sort both the lists of segments and the list of scan lines in order of use by the writing hardware.

The list of scan lines are sent to the interlace resolvers 314, 315 where the scan lines are separated depending on which beam they will be written by. New interlaced lists for each beam are assembled. In Figure 3 the list 317 is split into the interlace lists 318 and 319 that are sent to beam processor units, e.g. beam processor boards 320, 321, each with a beam processor 322 and a modulator 323. In the beam processor boards the

simplified geometry in the scan lists is resolved and converted to amplitude and time modulation of the laser beams. Since the beams are scanning the workpiece in parallel the interlaced patterns 324, 325 are reassembled in the exposed pattern.

Since only one field is written at a time only one interlace resolver can send data to the beam processors at a time as is shown by the heavy lines from 315 to 320, 321, unless the transfers are buffered so that the processing in the beam processors is decoupled from the datainput.

For a simple case with a small number of beams the distribution can be done by a multiplexor, i.e. a logic circuit that accepts a single input data stream from the segmentizer/segmentizers and directs data items to different outputs according to either their position in their stream or a tag in the data item.

Figure 3 shows the method in schematic form and in a practical implementation details may vary, e.g. the two modulators can be a single physical device with two channels, each segmentizer can use one or several processors etc.

Preferred embodiments

A preferred embodiment of the invention is in a three-beam laser writer for semiconductor reticles, as is shown in Figure 4. The writer has a distance between the scan lines of 0.25 µm and a shortest segment length of 0.25 µm. The maximum conversion burst rate in the beam processors is 60 million segments per second and the system is writing approximately 60 % of the total time. Accordingly the system writes 3 * 0.25 µm * 0.25 µm * 60% * 60 million = 6.75 sq.mm/s.

The data distribution network must be dimensioned for the worst possible case, i.e. the entire area filled with segments of minimum length, or else it is possible to supply an input data file that causes the system to

malfunction due to data overload. Each beam processor has a maximum burst rate of 60 million segments per second and each segment is described by two data bytes. The three beam processors therefore have a maximum data consumption of 360 Mb/s, corresponding to 180-240 Mb/s maximum sustained average rate.

The links between the interlace resolvers and the beam processors are implemented as a cross-switch network of parallel links. Each link has a transfer rate of 180 Mb/s and the shown network can at any time support three simultaneous transfers. The throughput of the links between the segmentizers and the beam processors is 3 x 180 mb/s = 540 Mb/s burst rate which is more than adequate for the worst possible pattern including overhead. Alternatively a simpler network can be used supporting two or only one transfer.

Figure 5 shows how generous buffers allow all components to work independent of all others. The heavy lines show current data transfers. The interlace resolvers (IR1-IR4) have two output buffers, one for storing new lists being worked on and one for storing the previous list waiting for transfer to the beam processors. Since the segmentizers are typically slower than the interlace resolvers the buffer memory between S and IR need not store any data, it needs only be large enough to allow S and IR to work in an asynchronous mode.

The beam processor units have FIFO buffers with room for several fields. Field n (Fn) is being written and is read from all FIFOs simultaneously, Fn+1 is transferred from IR1, while IR1 is working on Fn+5. IR2 and IR3 are one and two fields ahead of IR1, respectively, and the FIFOs of BP2 and BP3 are storing enough data to make the bottom of all FIFOs synchronized.

S4 and IR4 have just finished Fn+4 and IR4 is transferring the output from the work buffer to transfer buffer. At the same time the host computer HC is loading input data for a new field to S4. In actual operation the

scheduling and transfer of data is more irregular than Figure 5 leads one to believe, since the fields take different amounts of time to process and the scheduling is based on demand and availability. The buffer memories in Figure 5 need not be physically separate but may be different areas in the same physical memory, and they may be reassigned dynamically. The processors P1 to P8 may likewise be 8 physical processors, but they may also be another number and they may be dynamically reassigned between different tasks.

Figure 5 assumes that data needs to be loaded sequentially to the beam processor buffers. Using random-access writing instead of FIFOs would allow smaller buffer areas, but at the expense of more overhead and more complex management by the host computer. In the preferred embodiment FIFOs are used.

A real pattern will have a data requirement at least 4 times smaller than the maximum data rate or 45 - 67 Mb/s. A typical writing field is part of a swath 200 µm wide and 10 mm long needing an absolute maximum of 32 million segments or 64 Mb data, in practice not more than 8 million segments or 16 Mb data or 5.3 Mb per beam. 72 Mb buffer memory in the beam processor units (24 Mb in each unit) will then store several fields as shown in Figure 5. An occasional field with too much data will cause the FIFO buffer to fill up and the pipelining will be lost for a couple fields, but the system will recover gracefully. With a larger number of processors than beams the writing hardware need only wait for data transfers, not for processing since the subsequent fields are already in the transfer buffers in the IRs.

The size of the fields can be changed dynamically, so that the field size is made smaller for extremely dense patterns and larger for less dense patterns.

Even in the case where the data to the beam processors are only rectangular non-overlapping segments, the conversion from geometrical elements to time and power in

the beam processor uses a set of rules. First the geometry is converted to the hardware-supported time and power resolution. Secondly, the linearity between the power in the beam and the position of the edge is only approximate. When the beam is only slightly larger than the distance between two scan lines, the transient function is s-shaped and on some photo-sensitive materials there is an additional sag. Therefore it is advantageous to make an empirical calibration and store the calibration curve as a lookup table. Furthermore, if the geometrical linearity of the scan line is not perfect a stored geometrical correction table is useful.

The invention and embodiments satisfy the need for a real-time data conversion system for a wide range of applications, also the most demanding. In particular there is no hard limit to the number of processors that can be used in typical embodiments, since they use cross-switch network that is more easily extendible than bus systems. Systems designed according to the invention can also evolve with the rapidly increasing requirements on capacity. Since it is suitable to be built with standard processors, standard computer boards and software in portable high-level language, it can follow the technical development which has given a tripling of speed every two years in the past.

The terms and expressions which have been employed in the foregoing specification are used therein as terms of descritption and not of limitation, and there is no intention in the use of such terms and expressions of excluding equivalents of the features shown and descibed or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims which follow.

CLAIMS

1. A method for fast and accurate writing of very complex patterns on a light sensitive surface comprising the steps of:

providing at least two modulated focused laser beams scanning the surface in interlaced parallel scan lines;

providing for each beam a beam processor unit with data conversion logic and means for modulating said laser beam;

providing input data containing the geometries to be written on the plate in an input format, e.g. a list of polygons;

in a first conversion step fracturing the input data into writing fields, e.g. swaths;

in a second conversion step cutting the geometries in the fractured database into scan lines, and generating for each scan line a scan list containing geometries to be written in the scan line, so called segments, and performing said second conversion step in at least two parallel processors, so called segmentizers, operating simultaneously but on different writing fields;

further distributing said scan lists to the beam processor units in accordance with the interlacing of the scan lines; and

in a third conversion step converting in said beam processor units said scan lists of segments to analog power modulation sequences for said laser beams.

2. A method as in claim 1 where in the segments in the scan lists are simplified geometrical representations of those parts of the input geometries that fall in the scan line.

3. A method as in claim 1 or claim 2 where in the segments in a scan lists are non-overlapping.

4. A method as in any one of the preceding claims where in the segments in a scan lists are rectangles with a length and a width.

5. A method as in any one of the preceding claims where in the segments in the scan lists are sorted in the order they will be written by the scanning beam.

6. A method as in any one of the preceding claims where in the conversion in the beam processor units uses a set of conversion rules that are empirically calibrated.

7. A method as in any one of the preceding claims where in the conversion in the beam processor units uses at least one table-lookup function.

8. A method as in any one of the preceding claims where in the scan lists are distributed to the beam processor units via a cross-switch network.

9. A method as in any one of the preceding claims where in the scan lists are distributed to the beam processor units via a bus-system.

10. A method as in any one of the preceding claims where in the scan lists are distributed to the any one of the preceding claims beam processor units by a multiplexer.

11. A method as in any one of the preceding claims where in the data are pipelined through the second and third conversion steps without intermediate non-volatile storage.

12. A method as in any one of the preceding claims where in beam boards has an input buffer with room for the scan lists for at least two writing fields.

13. A method as in any one of the preceding claims where the transfer between the segmentizers and the beam processor unit are doubel buffered, in one output buffer in the segmentizer and in one input buffer in the beam processor unit.

14. An apparatus for fast and accurate writing of very complex patterns on a light sensitive surface comprising:

at least two modulated focused laser beams scanning the surface in interlaced parallel scan lines;

for each laser beam a beam processor unit with data conversion logic and means for modulating said laser beam;

means for accepting input data containing the geometries to be written on the plate in an input format, e.g. a list of polygons

data processing means for in a first conversion step fracturing the input data into writing fields, e.g. swaths;

parallel data processing means for in a second conversion step cutting the geometries in the fractured database into scan lines, and generating for each scan line a scan list containing geometries to be written in the scan line, so called segments;

data distribution means for distributing said scan lists to the beam processor units in accordance with the interlacing of the scan lines; and

data conversion and beam modulation means in the beam processors units for, in a third conversion step, converting said scan lists of segments to analog power modulation sequences on said laser beams.

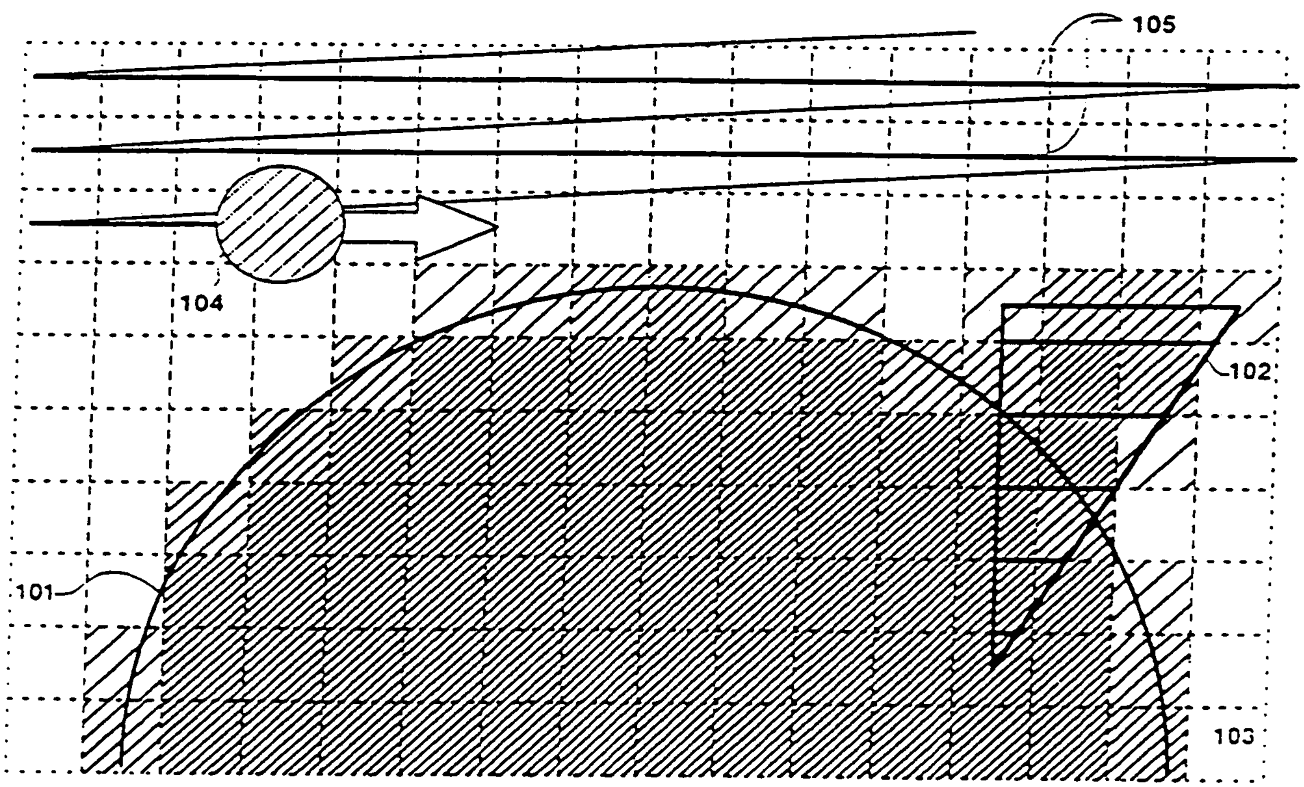

Figure 1a

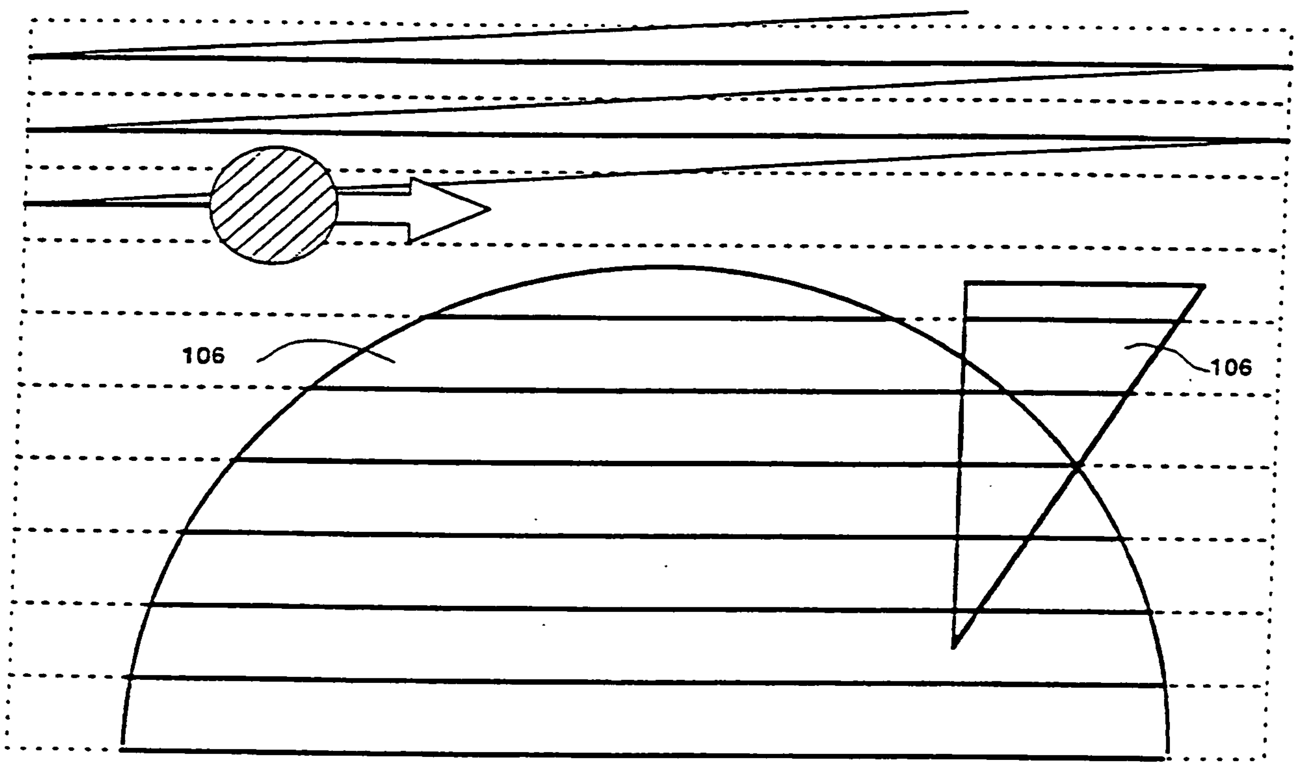

Figure 1b:

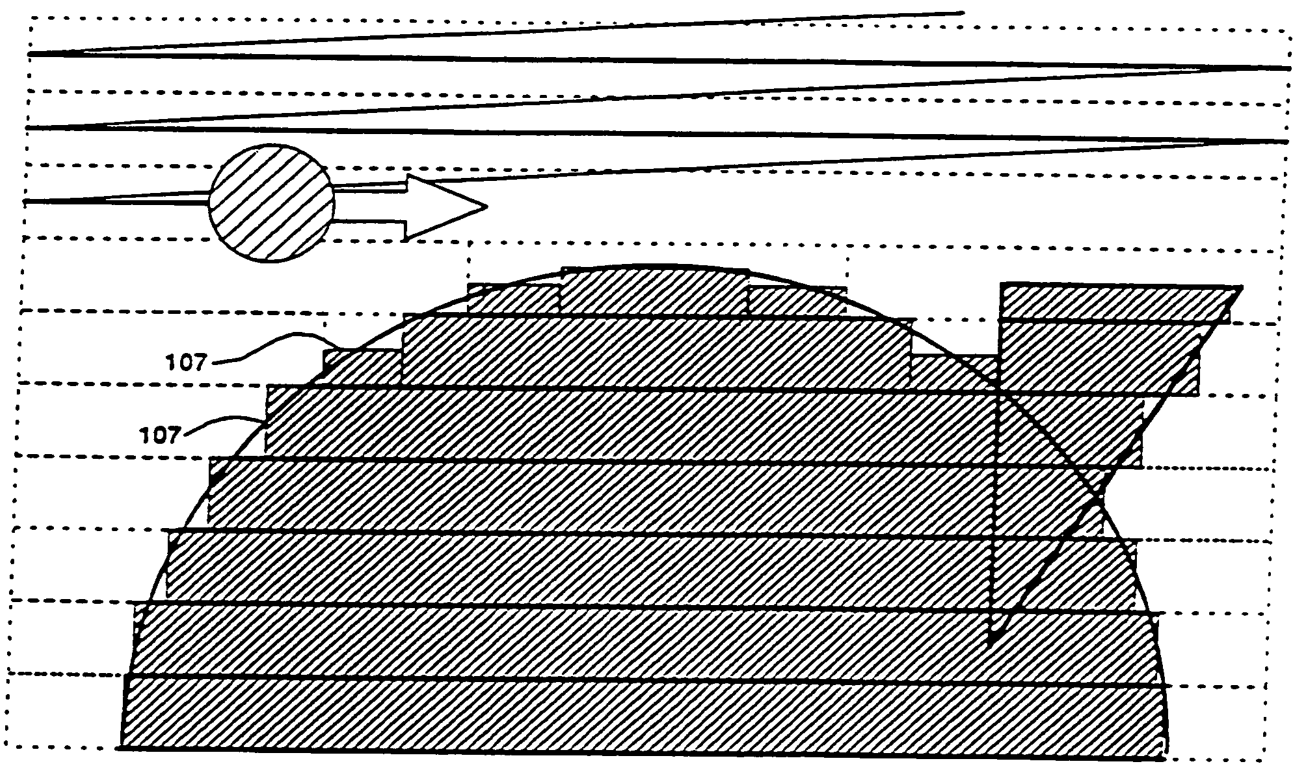

Figure 1c

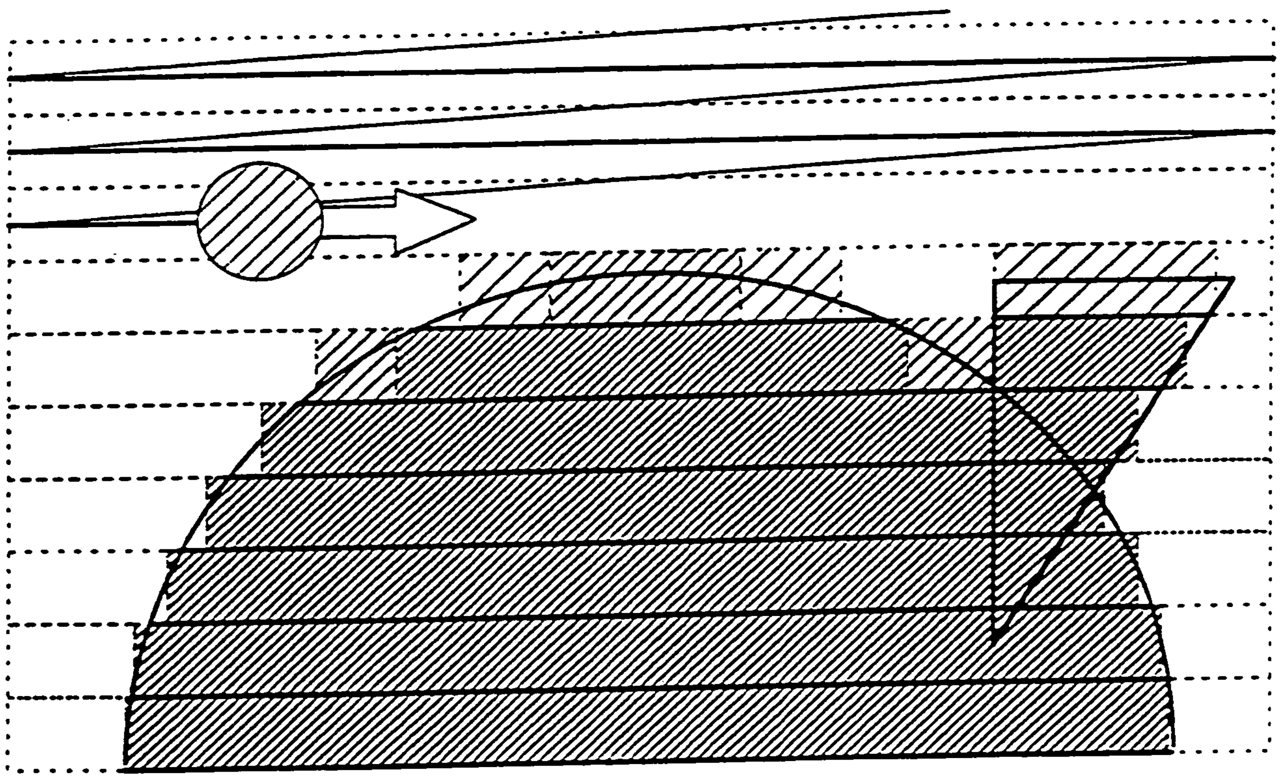

Figure 1d

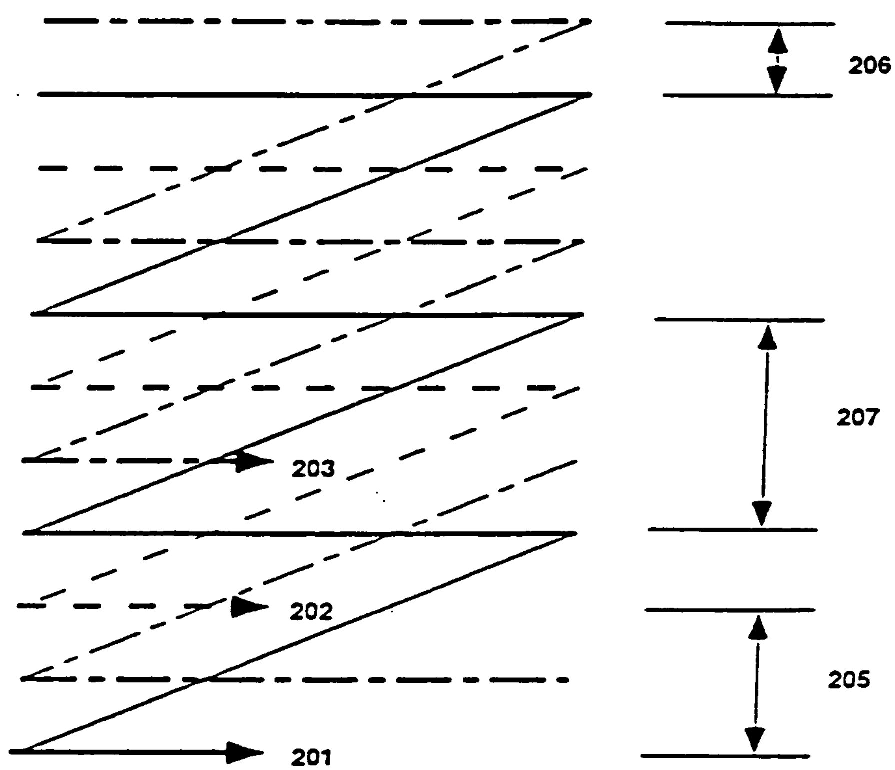

Figure 2

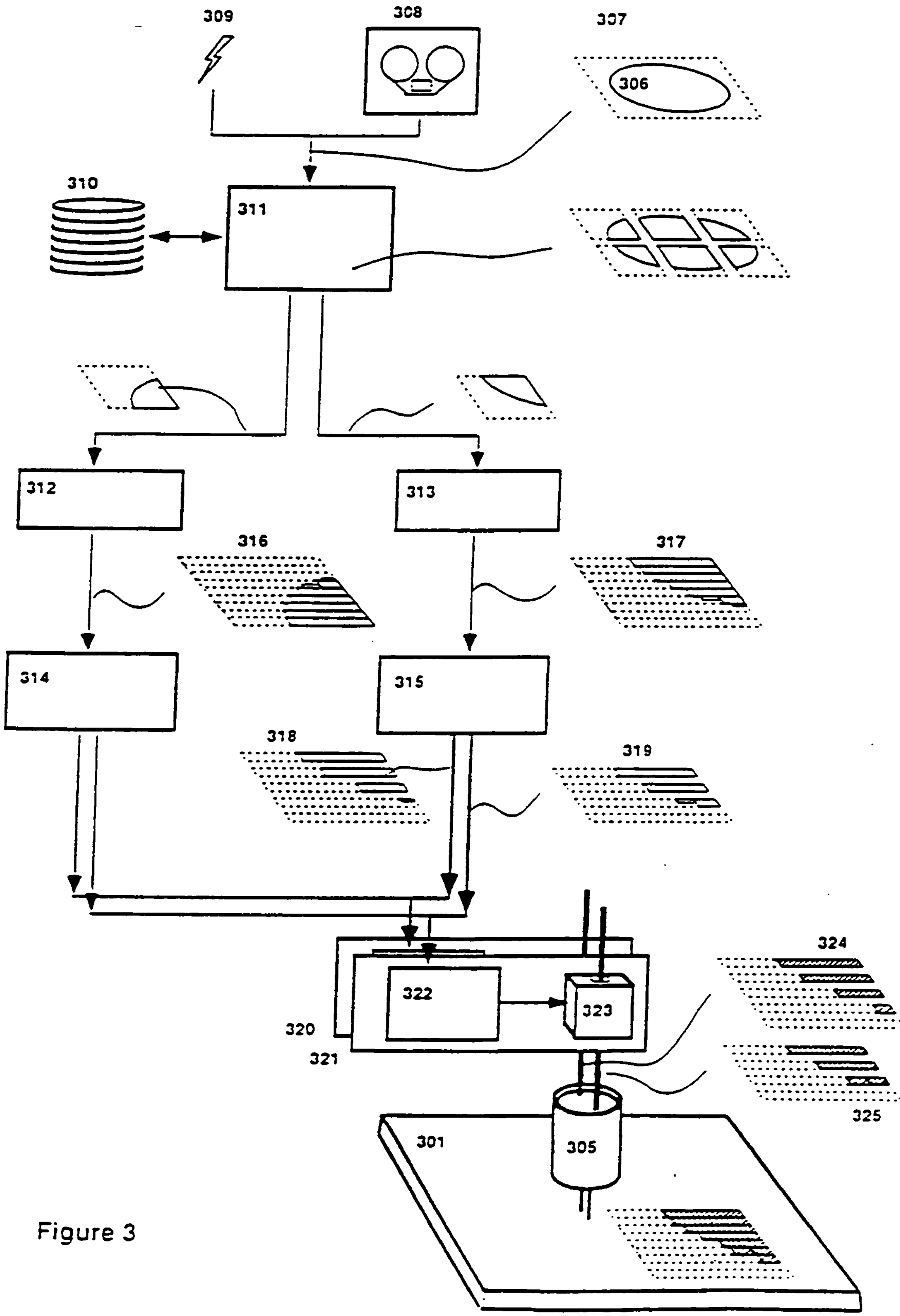
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Figure 3

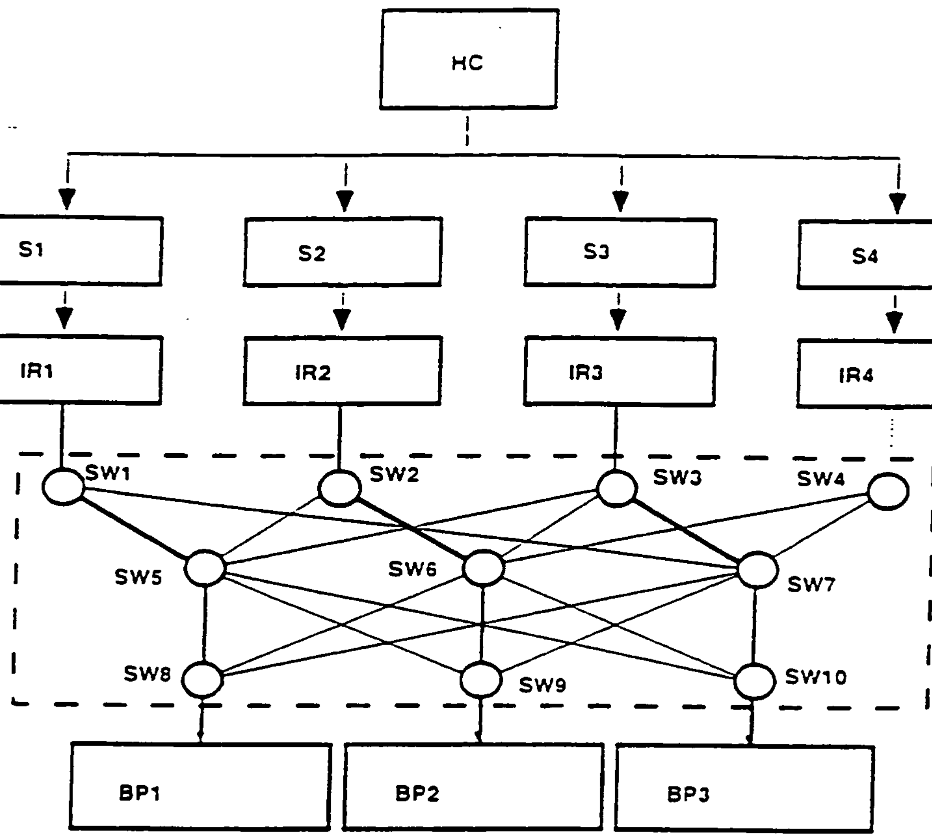

Figure 4a

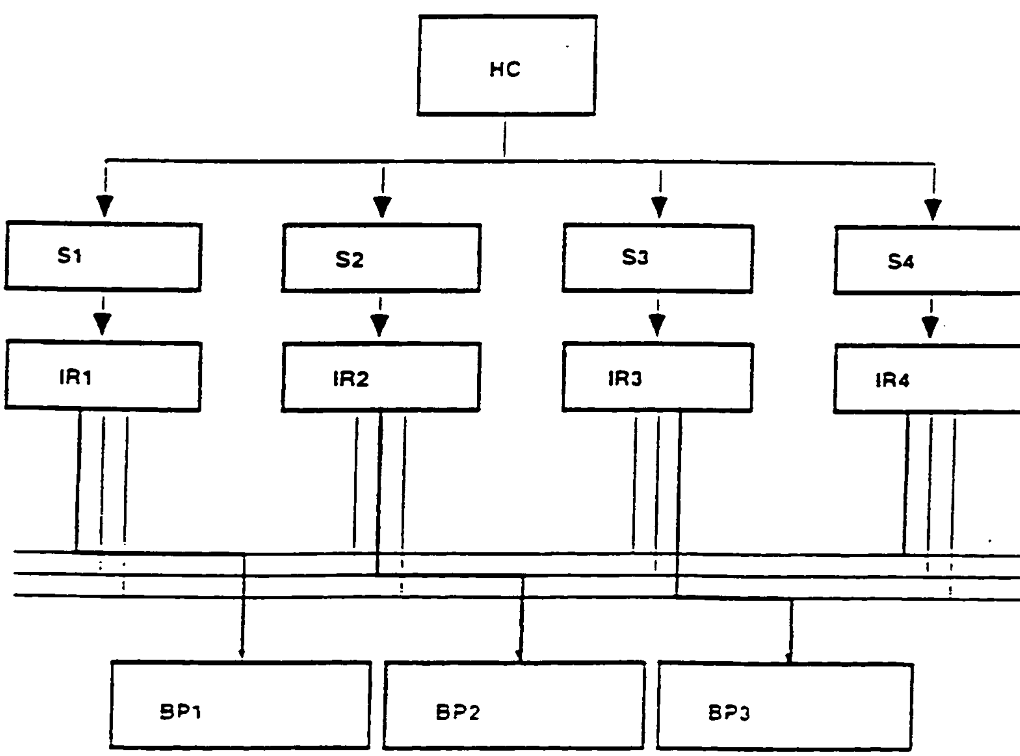

Figure 4b

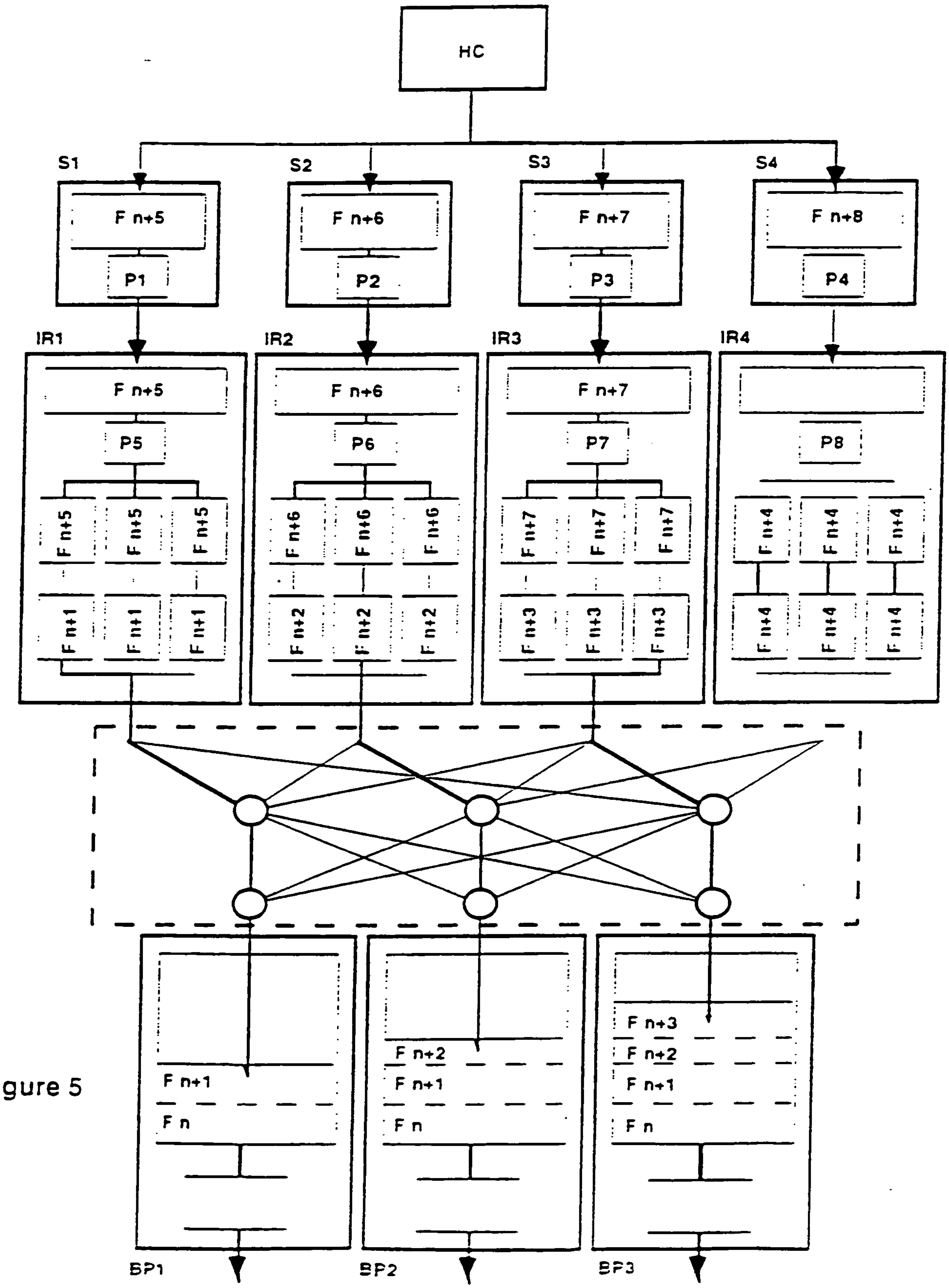
HC
S1
S2
S3
S4
F n+5
P1
F n+6
P2
F n+7
P3
F n+8
P4
IR1
IR2
IR3
IR4
F n+5
P5
F n+6
P6
F n+7
P7
P8
F n+5
F n+1
F n+6
F n+2
F n+7
F n+3
F n+4
F n+1
F n
F n+2
F n+1
F n
F n+3
F n+2
F n+1
F n
BP1
BP2
BP3

Figure 5